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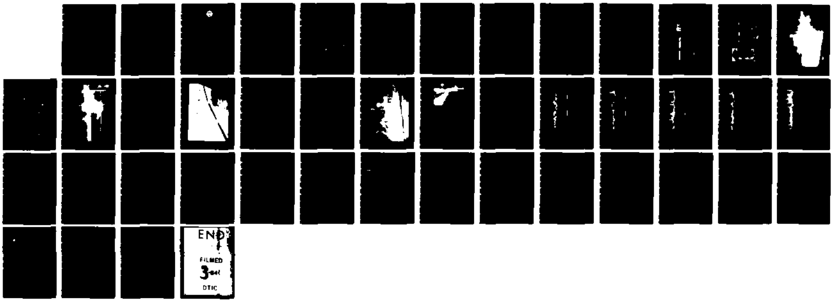

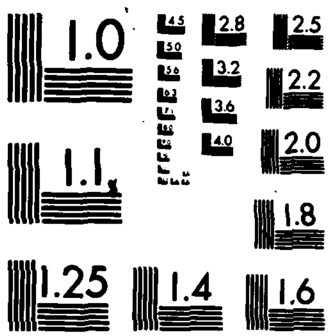

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SEAGRASS CONTROL PROJECT: CONTAINMENT BOOM EVALUATION

A method to protect seawater intakes from seagrass accumulation (NSAP Task SURFL-1-83)

H. W. Goforth, Jr.

1 October 1983
Final Report
March — September 1983

Prepared for
COMNAVSURFLANT

Approved for public release; distribution unlimited.

NOSC

NAVAL OCEAN SYSTEMS CENTER
San Diego, California 92152

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AN ACTIVITY OF THE NAVAL MATERIAL COMMAND

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Commander

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Technical Director

ADMINISTRATIVE INFORMATION

This task was performed in support of NSAP TASK SURFL-1-83 by the Biological Sciences Division (Code 514) of the Naval Ocean Systems Center, San Diego, California. This work was funded by the Navy Science Assistance Program Representative for COMNAVSURFLANT under program element 62721N, work request number N60921-83-WR-W0047. This report presents the findings of a 5-month test to determine the efficacy of a containment boom system to protect the seawater intakes of a PHM from blockage by drifting seagrass. The test was conducted at COMPHMRON-TWO stationed at Trumbo Annex Naval Station, Key West.

Released by
L.W. Bivens, Head
Biological Sciences Division

Under authority of
H.O. Porter, Head
Biosciences Department

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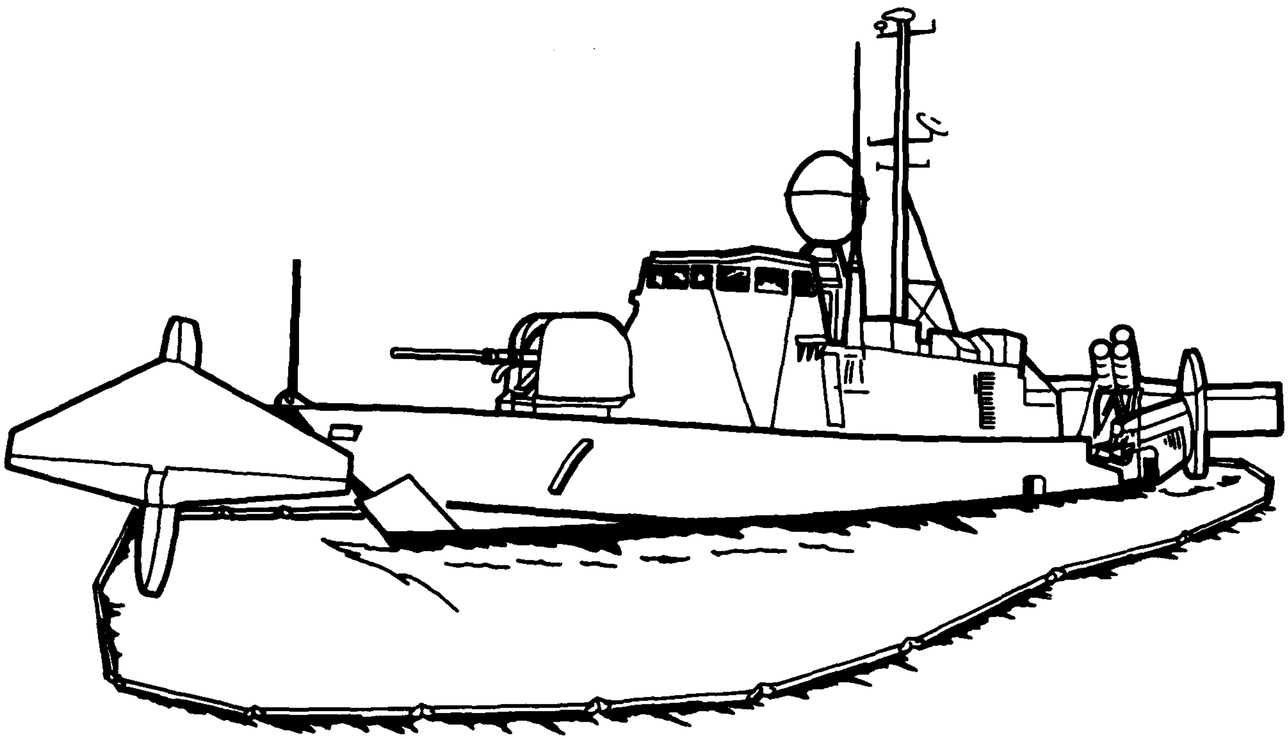
Blockage of shipboard seawater intakes by drifting seagrass has historically created significant engineering problems requiring diver assistance and/or pump replacement. Blockage can be successfully prevented using an off-the-shelf, GSA approved, containment boom system. A heavy-duty vinyl-coated nylon containment curtain (300 ft long X 4 ft deep) with 6-inch diameter floats and 1/4-inch galvanized chain ballasts was found to be effective in preventing drifting seagrass from entering a boomed test berth. This report presents the findings of a 5-month study conducted at Trumbo Annex, NAVSTA Key West with the assistance and cooperation of COMPHMRON-TWO.

SEAGRASS CONTROL PROJECT: CONTAINMENT BOOM EVALUATION

H. W. Goforth, Jr.



SUMMARY

Between April and September of 1983, the Biological Sciences Division (Code 514) of the Naval Ocean Systems Center conducted a 5-month test of a 300-foot containment boom system to protect the seawater intakes of a PHM from blockage by drifting seagrass. COMPHMRON-TWO was selected as the test site because of its permanent location in an environment with significant drifting seagrass and susceptible shallow-draft ships. The primary objective was to determine if a commercially available containment boom system could effectively solve the problem of seagrass blockage of seawater intakes of ships moored at NAVSTA Key West. During the 5-month test, drifting seagrass was present in the berthing area outside the boom on 37 days (30% of the time). Except for a 7-day period, when the boom's integrity was violated frequently to allow service craft access to the PHM, the boom was consistently effective in preventing seagrass from entering the protected PHM berth (experimental). Even though during the test period, no pump failures (due to seagrass) occurred on PHMs at unprotected berths (controls), the successful exclusion of seagrass from the test berth showed that containment booms offer an effective near term solution to the engineering problems associated with drifting seagrass. Further testing of containment booms at other mooring sites with significantly different physical and environmental conditions is recommended before full-scale application can be recommended.

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INTRODUCTION

Ships moored at NAVSTA Key West during the past few years have reported engineering problems associated with seagrass blocking seawater intakes and/or pumps (Figure 1). Corrective action frequently requires several hours of labor to remove the pump and clear the debris before it can be returned to full operation. Additionally, divers are frequently required to clear drifting seagrass and debris from the ship's intakes to restore suction pressure. Drifting turtle grass *(Thalassia testudinum)* is a natural phenomenon in the Florida Keys and is present throughout the year in varying amounts. The shallow water flats of the Florida Keys are populated with extensive turtle grass beds which experience both a daily and seasonal loss of leaves. When proper environmental conditions occur, large amounts of turtle grass break loose from these beds and form rafts of drifting seagrass (Figure 2). Under the proper wind and current conditions the seagrass is driven to shore and accumulates next to seawalls and ship hulls (Figure 3). Drifting turtle grass leaves take up to 22 days to lose their buoyancy and sink (Greenway, 1976) therefore, unprotected ships may be exposed to drifting seagrass accumulations for several days at a time (Figure 4).

A preliminary survey of the seagrass problem at NAVSTA Key West conducted in October 1982 by NOSC recommended that the most expedient near-term solution was to purchase and deploy an off-the-shelf seagrass/debris boom system. In February 1983, COMNAVSURFLANT requested that NSAP initiate a pilot program to select a boom system and test its effectiveness in protecting a PHM. In March 1983, NOSC was tasked with conducting a pilot test to: (1) evaluate the efficacy of a containment boom system in preventing seagrass accumulation at a PHM berth and (2) determine the most effective deployment procedures under a variety of environmental and operational conditions. This report presents the findings of a 5-month pilot test of a containment boom system deployed around a PHM moored at COMPHMRON-TWO, NAVSTA Key West (Figures 5 and 6).

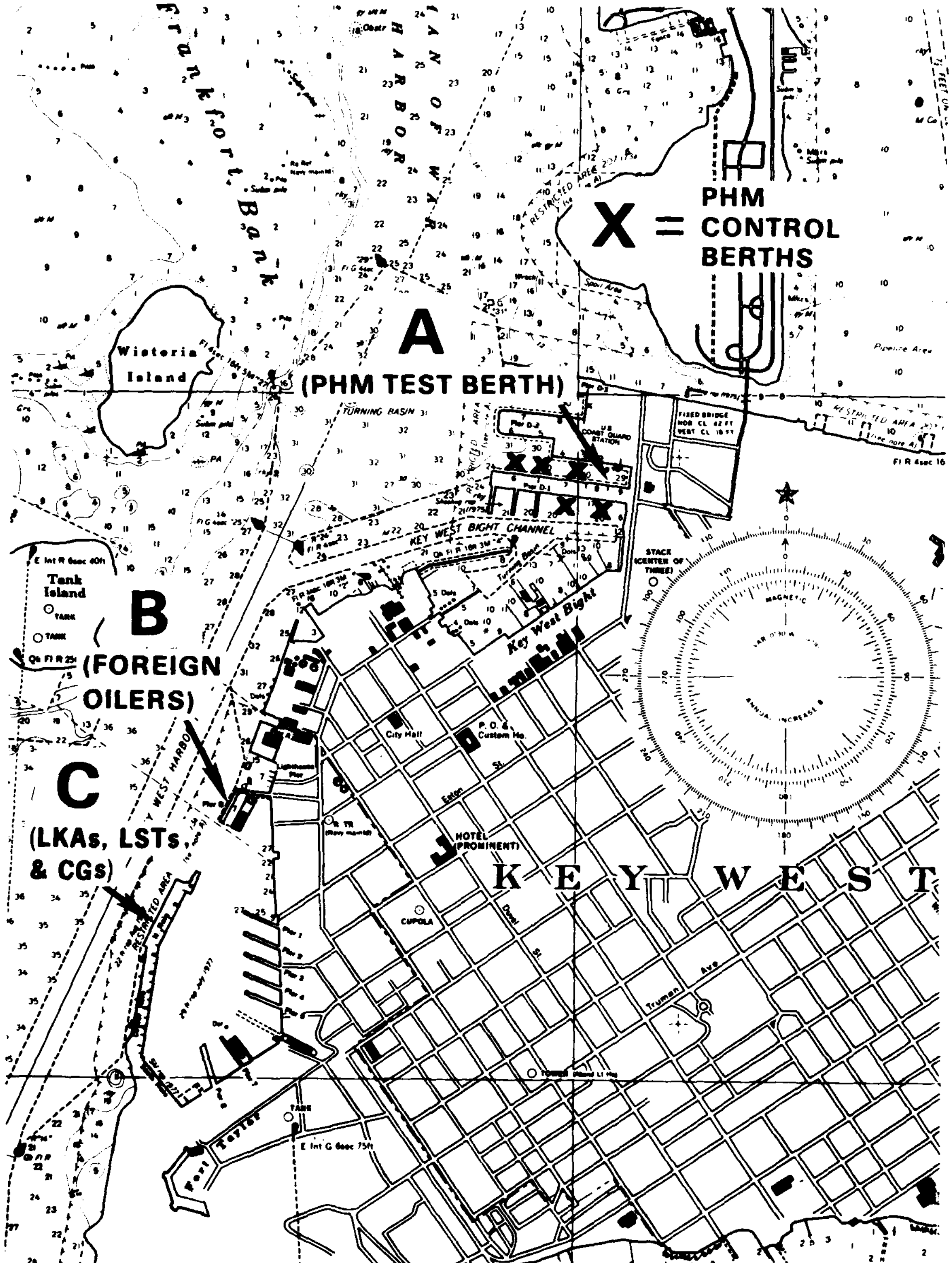

Figure 1. Location of mooring sites where ships historically experience seagrass-related problems with seawater intakes (Key West, Florida).

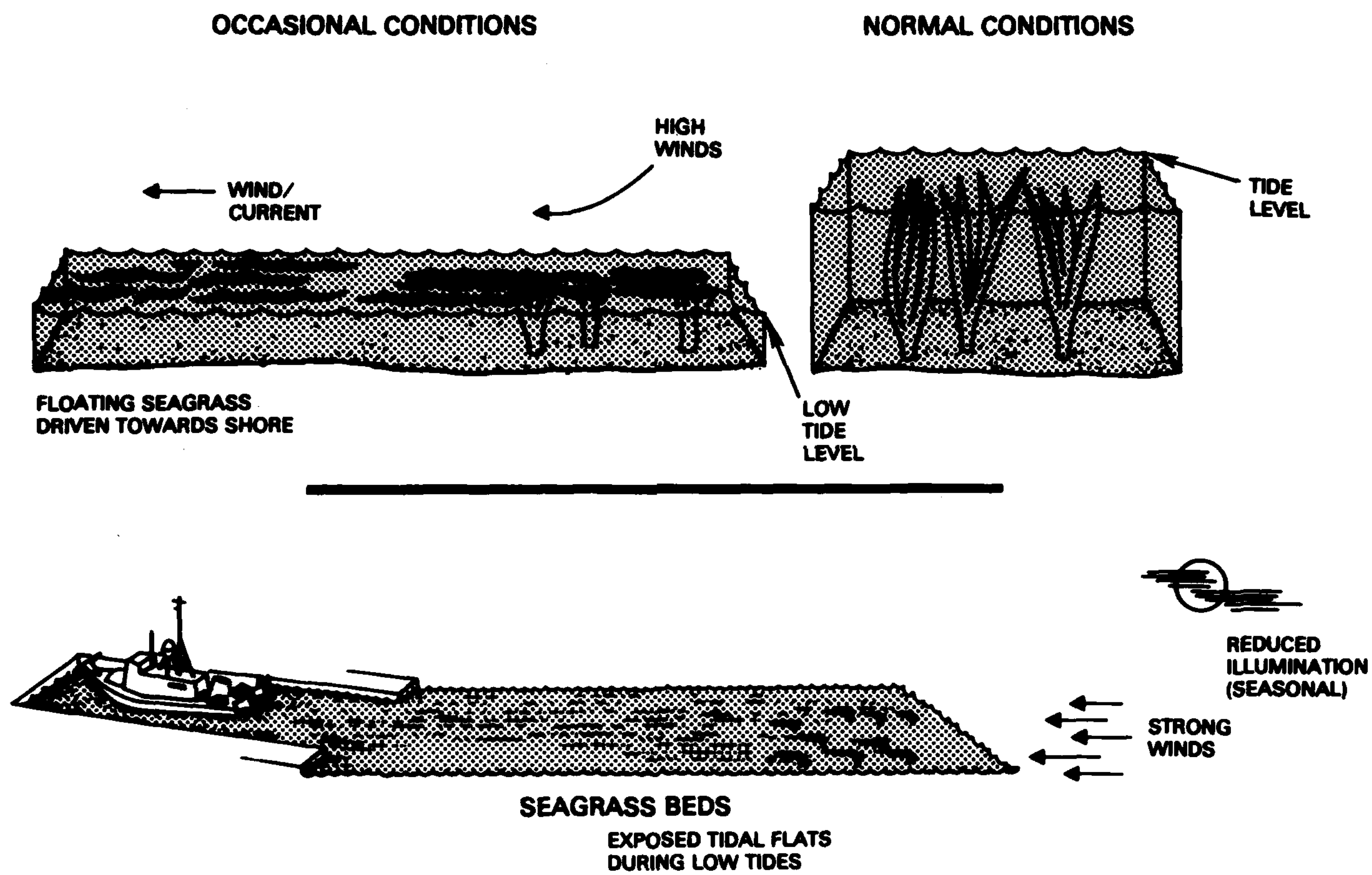

Figure 2. Environmental conditions associated with increased mass of drifting turtle grass.

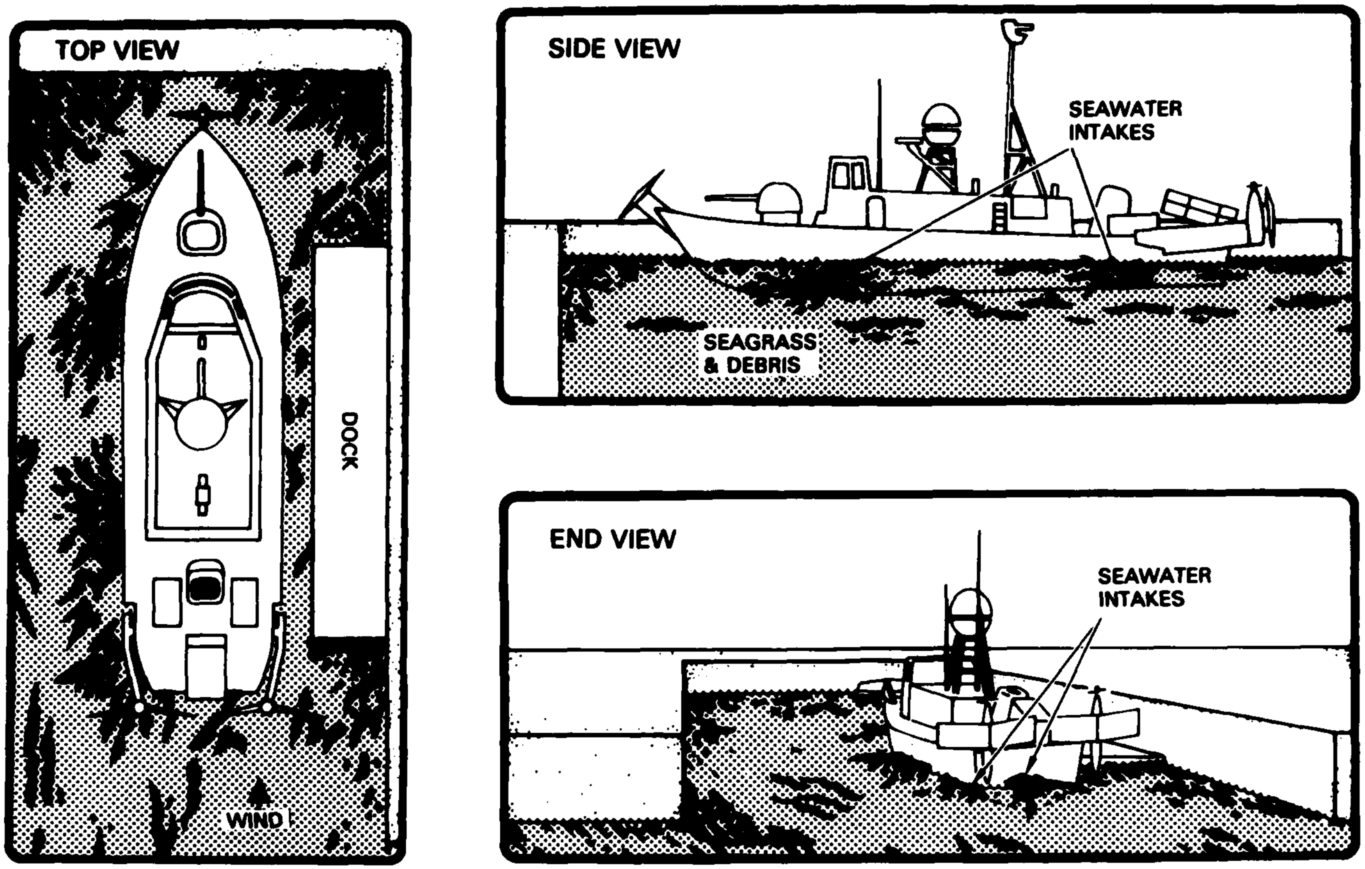

Figure 3. The effect of heavy accumulations of turtle grass upon ships moored at NAVSTA Key West.

Figure 4. PHM moored at Site A unprotected against drifting seagrass.

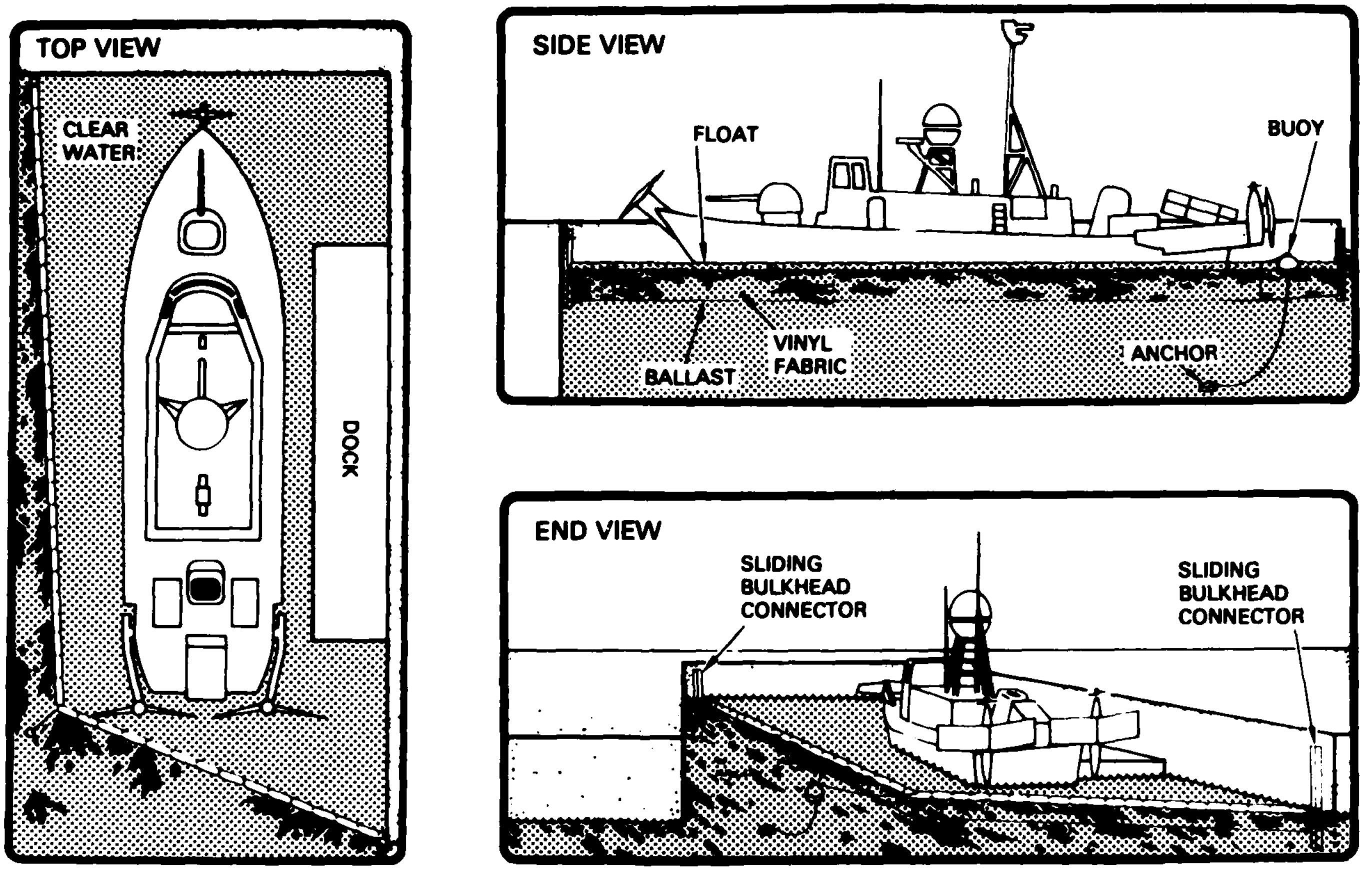

Figure 5. Diagram of containment boom deployment and mooring system to protect a PHM.

Figure 6. A PHM protected by a 300-ft × 4-ft containment boom system (Site A).

HISTORICAL DATA AND SITE DESCRIPTIONS

In the recent past, naval ships have reported problems with seagrass while moored at several sites in the Key West Harbor area. Figure 1 shows the location of three sites where ships have frequently reported problems with seagrass blockage of seawater intakes. Site A is located on Pier Delta-1 Trumbo Annex, NAVSTA Key West and served as the test berth for this study. Site B located on Pier Bravo, NAVSTA Key West, is where visiting foreign oilers frequently moor. While moored at Site B in June 1982, a British oiler (GREEN ROVER) required divers to clear its intakes of drifting seagrass. Site C, located on the outer Mole at NAVSTA Key West, is the normal berthing site for deep draft ships (e.g., LKAs, LSTs, LPDs and CGs). In the past few years, while moored at Site C, both the USS EL PASO (LKA 117) (September 1982) and USS TRENTON (LPD) (May 1980) experienced pump failures due to clogged seagrass. More recently (October 1983), also while moored at Site C, the USS DALE (CG 19) required divers to remove turtle grass from its intakes to regain suction and prevent pump failure.

EXPERIMENTAL DESIGN

The initial experimental design was to compare the frequency of seagrass-related pump failures at a protected berth with that of unprotected berths. The absence of seagrass-related pump failures on any of the PHMs during the 5-month test period was unexpected and required that the effectiveness of the boom in preventing pump failures be evaluated indirectly. The alternative design was to determine the boom's effectiveness in preventing seagrass from entering the protected berth area (Figure 7). This was quantified by dividing the number of days turtle grass was observed inside the boom by the total number of days turtle grass was observed in the area outside the boom. This approach may be considered an acceptable test of boom effectiveness for days when the integrity of the boom is properly maintained and when installed on a "grassless" day. However, on days when drifting grass is present within the berth before installation, extra care and work are required during installation and/or the grass must be manually removed from inside the boom after it is installed. The frequency of occurrence of drifting seagrass in the PHM mooring area was calculated by dividing the number of days grass was observed, by the total number of days that ships reported data. This statistic gives an indication of the potential for seagrass-related pump problems during this time period (April to Sept).

Figure 7. An example of the effectiveness of the containment boom system (Site A).

MATERIALS AND METHODS

CONTAINMENT BOOM AND MOORING SYSTEMS

The containment boom system purchased for this study at $9.00/lineal foot was made by Containment Systems Corp., Cocoa, Florida. It is a GSA item, listed as a modified "Performance Boom" and comprises:

(1) a 4-foot curtain made of high strength nylon, coated with yellow vinyl (22 ounce/yard),

(2) 6-inch diameter, oil resistant, closed cell polypropylene floats,

(3) 1/4-inch galvanized chain ballasts with double thickness fabric in the bottom of the curtain, and

(4) extruded aluminum, quick-connect end connectors to join the 100-foot sections of curtain.

Additionally, a 13-inch diameter mooring buoy and anchoring system were required to position the boom around the ship and hold it away from the ship's hull. This system cost $275.00 and comprised:

(1) two each, 13-inch diameter, closed cell, urethane buoys with a high impact plastic shell, a 1/2-inch diameter shaft through the center of the buoy which had a 3-inch diameter galvanized eye bolt on the top and a 1/2-inch diameter galvanized swivel on the bottom and

(2) two each, 18-pound hot dipped galvanized Danforth style anchors, secured to a buoy with 5/8-inch polypropylene line.

Initial deployment of the boom and buoy system included the installation of two each, 4-foot long X 4-inch wide (W6 X 12 AISI Design) "I" beams costing $127.50 each and two "floating bulkhead connectors" costing $108.50 each (No. SLBC 6X12, Containment Systems Corp.) to attach the curtain to the seawall. This method of attachment was used for only one end of the boom due to the condition of the concrete seawall. The other end of the boom was simply secured by a line to a bollard, cleat, or fixed point on the pier.

> (NOTE: This method does not insure a 100% effective oil seal between the curtain and the seawall, however under the conditions of this study, its effectiveness with drifting seagrass appeared quite acceptable.)

The initial anchoring system also required modification because of the soft bottom condition. It became necessary to replace the Danforth style anchors with 200-pound concrete clumps to maintain a solid moor in the soft muddy bottom. Once installed, the clumps could be moved and positioned while suspended from their anchor lines and did not require lifting aboard the skiff.

INSTALLATION AND DEPLOYMENT PROCEDURES

To properly install and deploy the 300-foot containment boom and anchor systems under light-moderate wind and current conditions required:

(1) A 15- to 20-foot skiff powered by an 18- to 25-horsepower outboard and

(2) a 3- to 4-man team with good seamanship skills.

(NOTE: larger boats lack the required maneuverability and additional personnel tend to decrease team efficiency.)

The installation procedure involves the following steps:

(1) Secure the up current end of the boom to the seawall.

(2) Attach the other end of the boom to the skiff and tow the boom around the ship to be protected (Figure 8).

(3) Secure the boom to the seawall at its down current attachment point.

(4) Attach the buoys with clumps to the predetermined attachment points on the curtain.

(5) Tow the boom to its proper "taut" position and lower each of the clumps into position well outside the boomed area.

To achieve an optimum deployment arrangement, the boom should form an arc and be relatively taut (Figure 6). Minor adjustments to the mooring system (e.g., anchor line length, position of clumps, slack at low tide, etc.) may be required during the first few deployments until the team develops experience with the procedures and familiarity with the environmental conditions. An experienced team of 3–4 men can deploy the boom in 15–20 minutes and remove it in 10 minutes.

The removal procedure involves the following steps:

(1) Disconnect each of the buoys from the boom.

(2) Attach the up current end of the boom to the skiff and tow the boom to its down current attachment point.

(3) Store the boom either (a) temporarily, alongside the seawall (Figure 9), or (b) out of the water, protected from destructive environmental factors, for anywhere from weeks to months.

(4) Depending upon the ship's maneuverability and buoy location, the buoys and clumps are left in place or relocated for convenient access in the future.

Appendix A contains a guide to containment boom selection, installation, and maintenance prepared by Containment Systems Corporation.

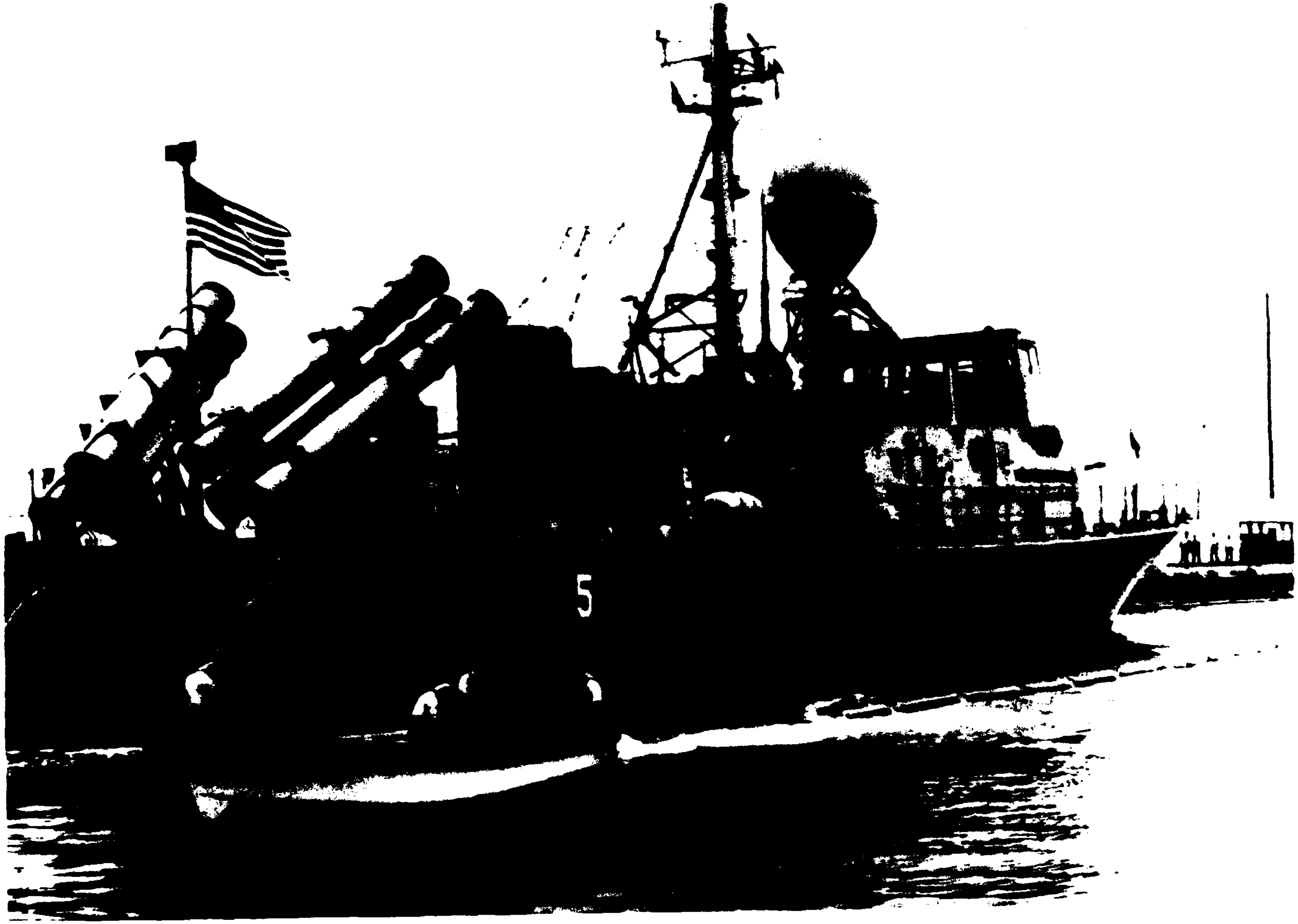

Figure 8. Deployment procedure for containment boom using a small boat (Site A).

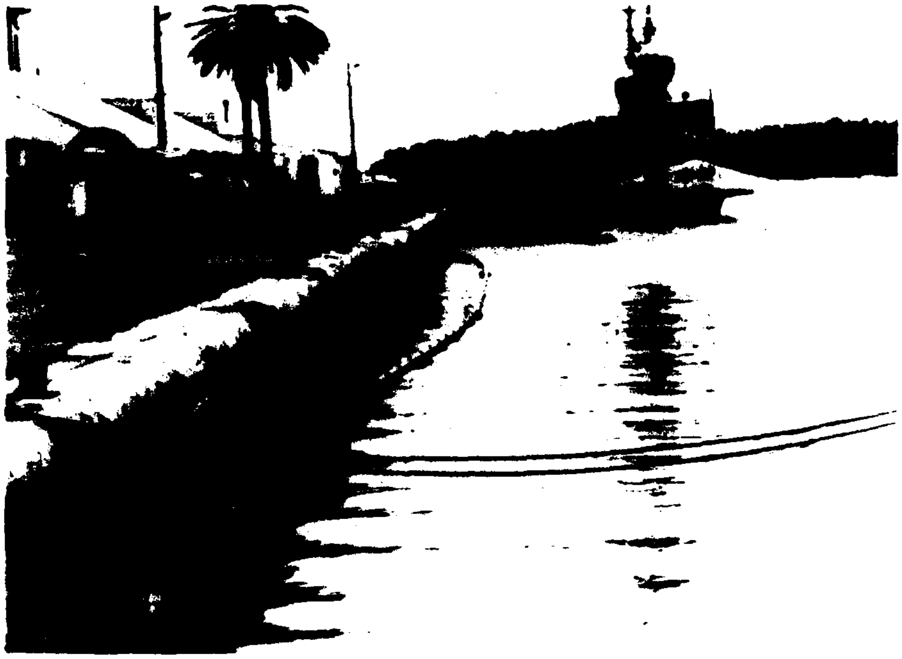

Figure 9. Temporary storage of the containment boom alongside a seawall (Site A).

DATA COLLECTION

Appendix B contains a sample of the "Seagrass Control Daily Data Report Form" and the "Incident Report Form" used by the PHMs participating in this study. The first form reports the presence and absence of seagrass inside and outside the area protected by the containment boom. The second report was designed to obtain a complete description of the environmental and operational conditions surrounding seagrass-related pump failures occurring during the test period. Appendix B also contains an historical review of PHM pump failures during the period January 1982 to August 1983 (by Mr. Les Jackson of HYSAT, a PHM contractor). Four US ships attached to COMPHMRON-TWO participated in the study: the PEGASUS PHM-1. HERCULES PHM-2, ARIES PHM-5, and GEMINI PHM-6. During the 5-month study (152 days), data were reported by the test ships for 122 days while moored at Site A. Daily environmental data were obtained from the Key West NOAA Weather Station and augmented by a monthly summary obtained from the National Climatic Data Center in Ashville, North Carolina. Tidal and current data were obtained from the "Tidal and Current Tables for North America" published by NOAA of the U.S. Department of Commerce.

RESULTS

ENVIRONMENTAL DATA

Correlations of the presence of drifting seagrass with seasons and environmental conditions revealed trends but could not be used to develop a predictive equation or probability table. Multifactorial statistical analyses however, may identify significant correlations that could predict periods of heavy seagrass accumulation. Figures 10, 11, 12, 13, and 14 graphically present monthly summaries of the data collected during the 5-month test of boom effectiveness. The purpose of this study was not to develop predictive models or determine cause-effect of seagrass presence at NAVSTA Key West. However, the following is a brief analysis of the environmental data collected during this study.

April had seagrass present the greatest percentage of time, was the month with the greatest number (29) of low tides below the 0.0-foot tidal level, and had the greatest number of days (7) when the average wind speed was above 15 mph (Figure 10). This is significant because turtle grass lives below 0.0 feet and is exposed to the combined dehydration effects of the sun and wind only during these tides. Other factors are obviously involved since drifting turtle grass exists in significant amounts during months having the least number of low tides (6-0) below 0.0 feet and the lightest winds (e.g., Aug-Oct). It is hypothesized that different environmental factors are responsible for the winter and summer leaf losses. Appendix C presents a Review of Seagrass Biology and addresses the environmental factors that affect growth and survival.

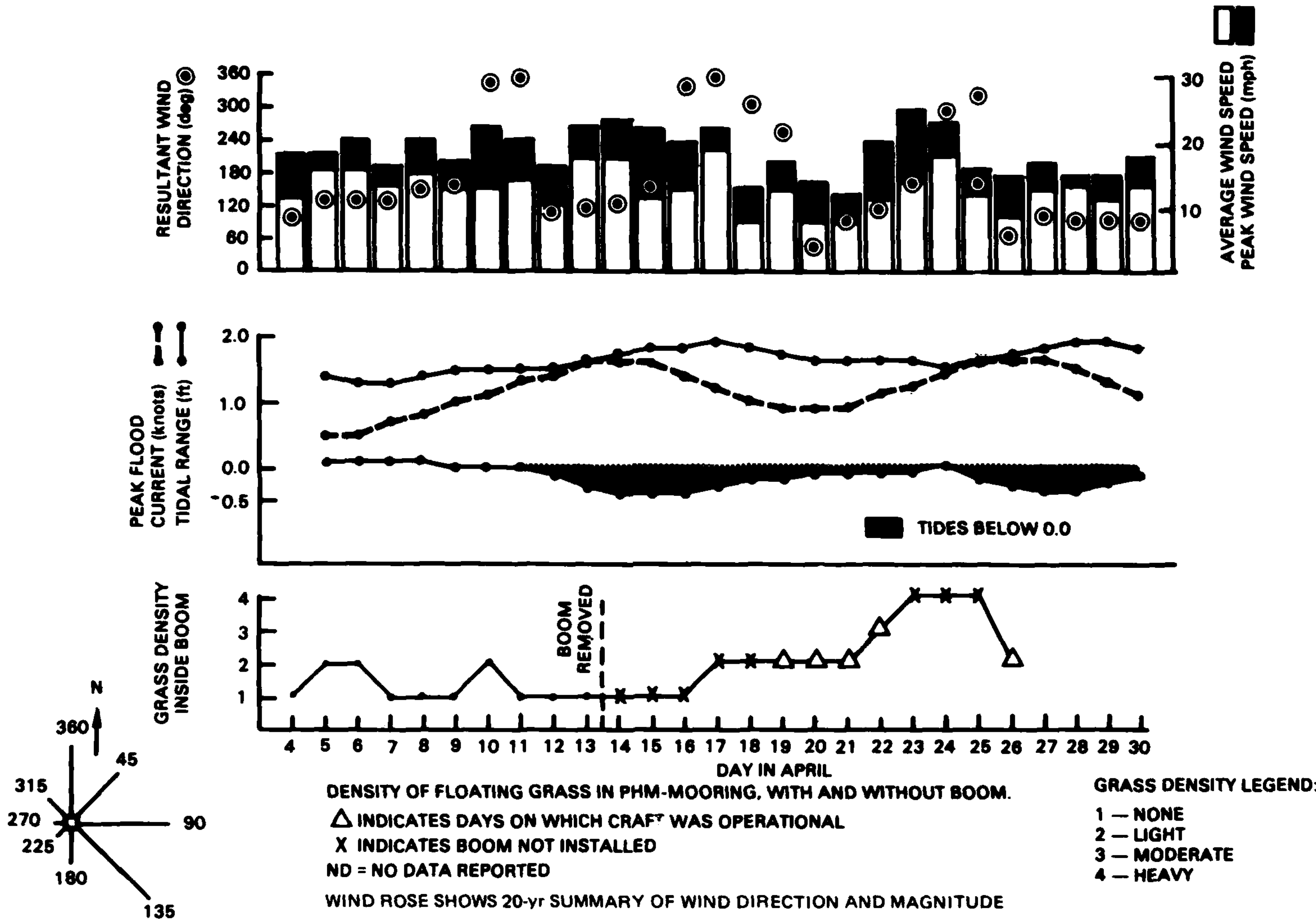

Figure 10. Monthly summary of weather, tidal, and turtle grass control data for April 1983.

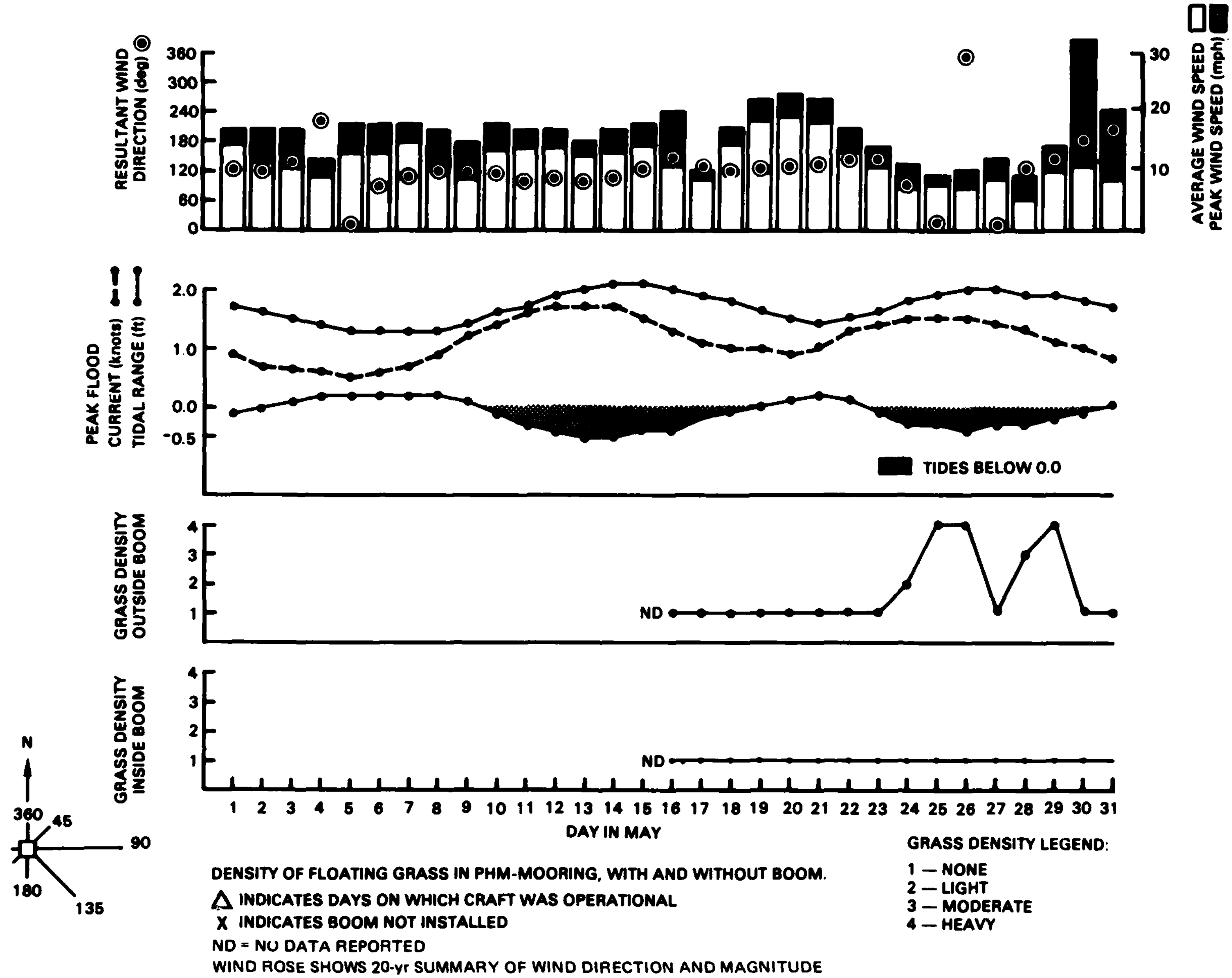

Figure 11. Monthly summary of weather, tidal, and turtle grass control data for May 1983.

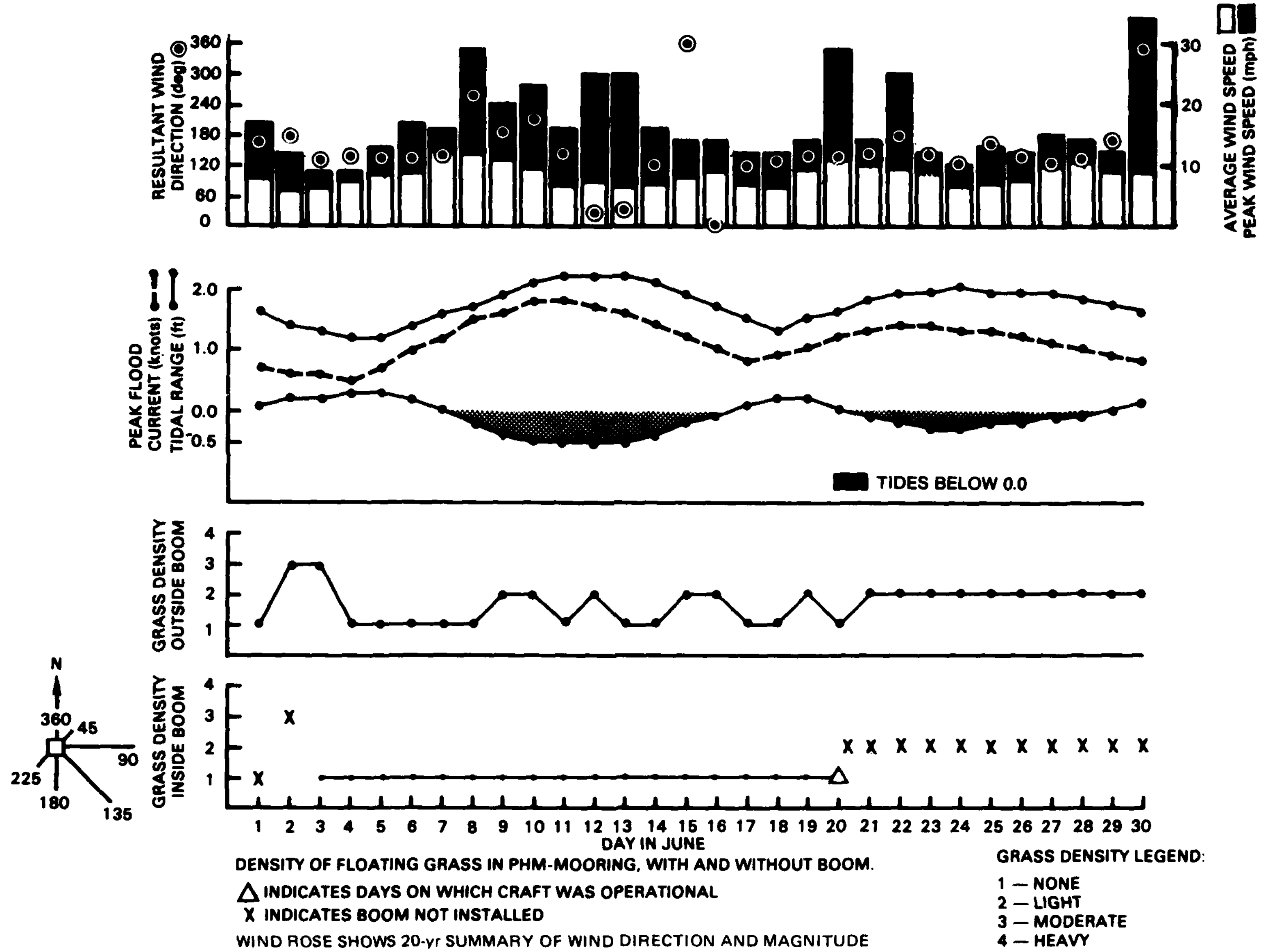

Figure 12. Monthly summary of weather, tidal, and turtle grass control data for June 1983.

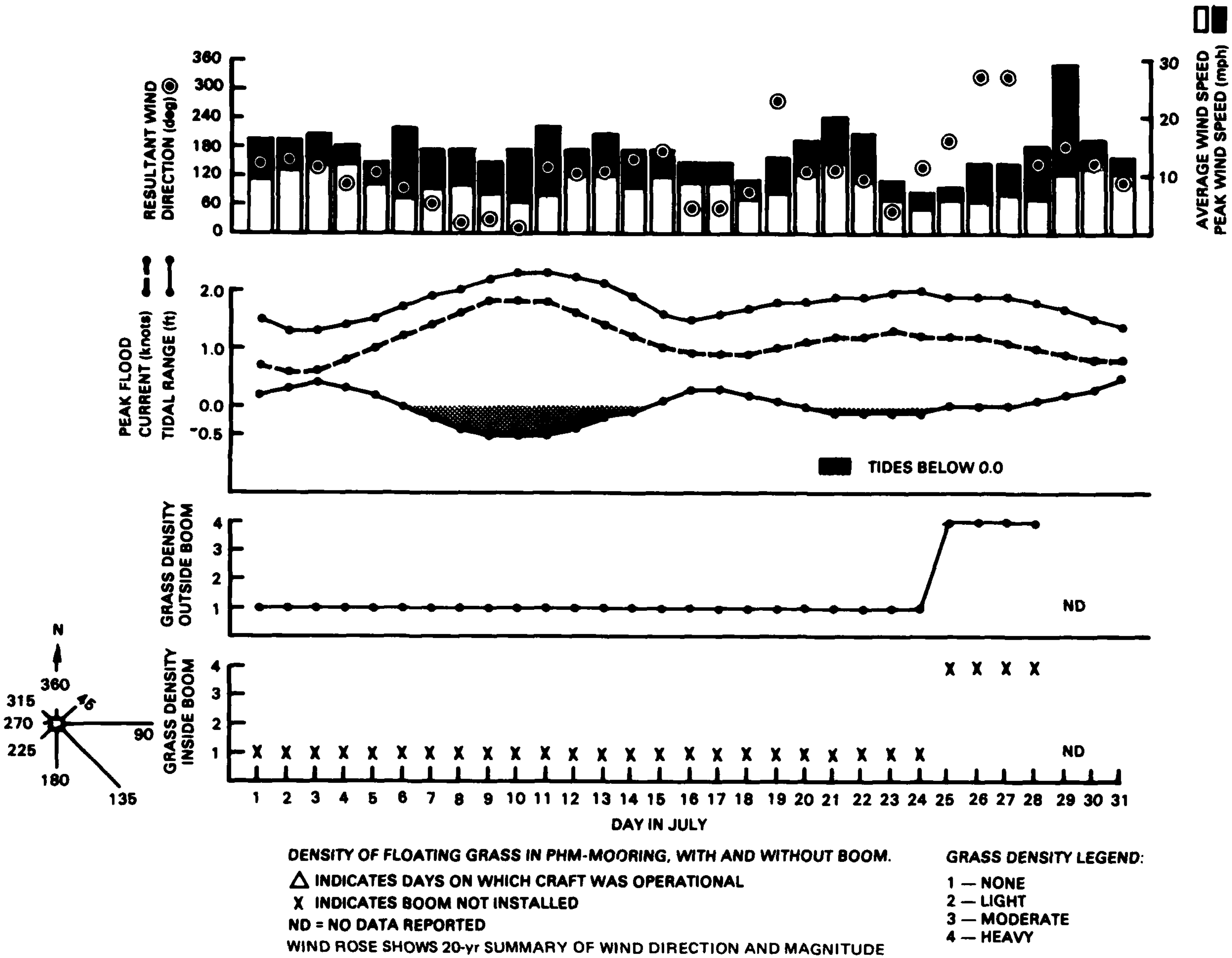

Figure 13. Monthly summary of weather, tidal, and turtle grass control data for July 1983.

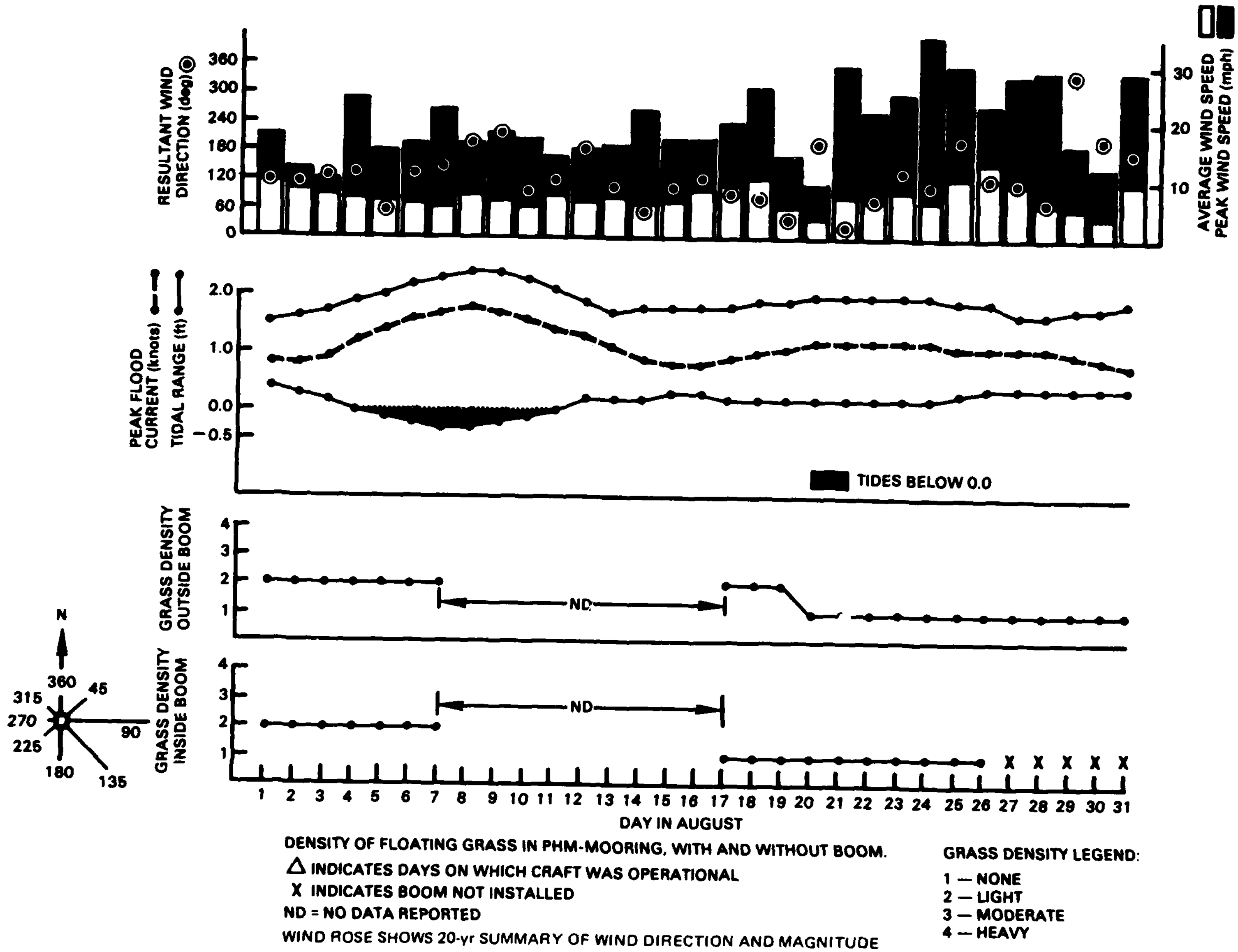

Figure 14. Monthly summary of weather, tidal, and turtle grass control data for August 1983.

BOOM EFFECTIVENESS

The data for this study were collected during the period 4 April–31 August 1983, at Trumbo Annex, NAVSTA Key West, and are summarized in Table 1. During this period the boom was deployed around a PHM 63 days (50% of the time) (Figure 6). During this study drifting turtle grass was present in the berthing area on 37 days (30% of the time). In August, grass was reported inside the protected area on 7 days when grass was also present outside the boom. During that week however, the boom had been frequently moved to permit service craft access to the USS ARIES and as a result, the boom integrity was violated. No attempt was made to remove the captured grass until USS HERCULES replaced USS ARIES at the test berth. Other than this 7-day period, the boom was consistently effective in preventing drifting turtle grass from entering and accumulating inside the test berth (Figure 7). Interviews with COMPHMRON-TWO personnel, however, revealed that under high wind and current conditions an improperly deployed boom will allow some grass to enter the protected area. If the guidelines presented in Appendix A are followed properly, the boom will provide the required protection from drifting seagrass and prevent blockage of intakes.

In October 1983, USS DALE (CG 19), while moored at Site C, experienced problems with its seawater intakes due to blockage by drifting seagrass and required diver assistance. In an effort to help alleviate this problem, COMPHMRON-TWO assisted by temporarily relocating the containment boom system to protect the stem of the USS DALE from drifting seagrass. During the 3 days the boom was deployed at Site C, no pump failures occurred aboard the DALE. The success of this unscheduled test of the containment boom system was encouraging and demonstrated that the boom can be effective in a variety of situations and deployment arrangements (Appendix D).

Table 1. Frequency of occurrence of turtle grass in test area.

PARAMETER	APR	MAY	JUN	JUL	AUG	TOTAL
Number of Days Grass Present in Pier/Berth Area	10	5	8	4	10	37
Number of Days Grass Present Inside the Boom When Grass Present in Pier/Berth Area	0	0	0	0	*7	*7
Percentage of Time Grass Present in Pier/Berth Area	38	31	27	14	32	30

*Days when boom integrity was violated for significant periods of time to allow service craft into the protected berth.

DISCUSSION AND CONCLUSIONS

The ability of containment boom systems to protect seawater intakes of naval ships from blockage by drifting seagrass (and debris) was tested and determined to be highly effective. Even though during the test period, no pump failures (due to seagrass) occurred on PHMs at unprotected berths (controls), the successful exclusion of seagrass from the test berth showed that containment booms offer an effective near term solution to the engineering problems associated with drifting seagrass. Nonetheless, the other data from this study and the anecdotal report of the boom's effectiveness (USS DALE CG 19) provide sufficient evidence to conclude that these booms are effective in preventing seagrass from blocking seawater intakes and therefore, are effective in preventing pump failures. Further testing of the containment boom at other mooring sites may be needed to determine the most effective deployment pattern for the different ship types. Modified procedures may also be needed to deploy the boom under a different set of physical and environmental conditions. One modification, suggested by the boatswain's mate in charge of boom deployment was to use 50-foot vice 100-foot sections to increase the boom's maneuverability and deployment possibilities.

At the conclusion of the study, the boom curtain material was still in good condition but had begun to show evidence of marine fouling on the inboard side. Also, some of the quick-connect aluminum pins had corroded during the study and had to be replaced with stainless steel. According to the manufacturer, under normal conditions when the curtain is cleaned monthly, the useful life of this containment boom system is 7–10 years. Thus the cost-effectiveness of this solution to the control of drifting seagrass appears quite favorable when the purchase price ($9.00/lineal foot) is amortized over its useful life span.

APPENDIX A

A GUIDE TO CONTAINMENT BOOM SELECTION, INSTALLATION AND MAINTENANCE

CONTAINMENT SYSTEMS. CORP.
P. O. BOX 1390 658 SO. INDUSTRY RD., COCOA, FLORIDA 32922
(305) 632-5640

GUIDE TO TURBIDITY CURTAIN SELECTION AND OPERATION

Curtain Selection: Containment Systems curtains are made for three general conditions.

1. Calm protected areas, i. e. lakes with little or no current. For this condition the Lightweight curtain is recommended.

2. Streams and rivers where the current runs in only one direction. The Middleweight curtain is recommended.

3. Tidal areas where currents change due to tidal and wind action. The Double Cable Heavyweight type curtain is recommended for these areas.

Depth of Curtain:

1. In lake areas the curtain should not rest freely upon the bottom. Avoid excessive large pleats lying on the bottom. To do so would cause the pleats to fill with thousands of pounds of silt, thereby creating a problem in removing the curtain.

2. In streams and tidal areas there is no way to keep the curtain near the bottom since the current must escape beneath it. The curtain should be as near the bottom as possible. Therefore, it should be ordered approximately the depth of the water. When installed the current will cause it to rise off the bottom.

3. In tidal areas the length of the skirt should be the depth of the water at high tide. True, you will have some curtain on the bottom at low tide but not sufficiently long to have a serious build-up of silt. The reversing tide will dump out the silt.

Length of Curtain:

1. In swift flowing water allow sufficient length to slant the curtain from shore to shore. This reduces curtain pressure and lets it hang nearer to the bottom. The more slant you give it the less pressure you have. Even in calmer water a little slack will make installation easier and give the curtain protection by reducing stress from wave action during high winds.

CONTAINMENT SYSTEMS, CORP.
P. O. BOX 1390 658 SO. INDUSTRY RD., COCOA, FLORIDA 32922
(305) 632-5640

Curtain Installation: Very few installations are the same. A few examples will be mentioned.

1. River with current where entire river crossing must be protected. First set your shore anchor points. A good post with a dead man is recommended. Tie off one end of curtain to the upstream anchor point. Then, if possible, lay the curtain along the bank from that point upstream the entire length of the curtain. (Keep the curtain furled until installation is complete.) Take a boat and tie upstream end of curtain to the boat. Then let current and boat under power take the curtain across the river to the downstream anchor point. For lengths less than 300 feet, anchors are not needed. Over this length you may add anchors as required; depends on current. Be sure the anchor is accompanied with a buoy or else it will pull the curtain under the water under extreme current.

2. River with current where you are protecting a small area on the side. Set both downstream and upstream anchor points so the curtain will form a half moon of sufficient size for the work to be done. Fasten curtain to upstream anchor point. Let it drift down and fasten downstream anchor point. Then begin at the top with good heavy anchors and anchor it off in designed half moon configuration.

3. River with swift current where you desire to enclose a dredge or the discharge area. Since the silt cannot run upstream a half V will do the job. The bottom of the V should be downstream. Make it exceptionally long to cut down on current pressure. Anchors may have to be used on both sides under severe conditions.

Tidal Areas: Double Cable Center Tension type curtain is recommended. This curtain always has a tension member in the proper place when tide reverses.

1. Assume you want to enclose a discharge area out in the bay. A circle, rectangular or diamond configuration is acceptable. But, anchors must be used on both sides of curtain or else the current will over-run them during tide change and spring the flukes out of their holding position causing them to ease their hold on the bottom.

2. Inshore work: Use half moon configuration. Anchors well set on the outside should be sufficient. To provide ingress and egress for work boats to service the dredge, disconnect one section on the up tide side - the silt will not travel up stream. When tide gets slack connect this section together and open a section on the other side when the tide starts running.

CONTAINMENT SYSTEMS, CORP.
P. O. BOX 1390 658 SO. INDUSTRY RD., COCOA, FLORIDA 32922
(305) 632-5640

Lakes and Pond Areas: Just set your anchor points and deploy the curtain in a furled condition. Put in all intermediate anchors then cut furling ties and let the skirt fall into position.

Anchors: Do not be tempted with light anchors. The pressures are great and the rule of thumb should be "over kill" as far as anchors are concerned. The bottom conditions will determine the best type of anchor. Danforth type is used in sandy bottoms, heavy kedge type or mushroom anchors should be used in mud bottoms.

Furling Ties: Never cut the furling ties prior to deploying the curtain. Once the skirt has been dropped the water pressure builds up and makes moving the curtain a very tough job.

Removing the Curtain: The best method we have found is to take a light skiff with two men and start at one end of the curtain. Let it come across the boat and furl the curtain as you slide the boat under it until you reach the other end. Then tow the curtain out.

Cleaning: If the curtain has been in the water long enough to collect barnacles and marine growth it should be cleaned immediately when removed from the water. If you let it dry before cleaning these barnacles get hard like bits of cement. The best method is to find a flat smooth place. Stretch out the curtain and go over it with a stiff bristle brush. If need be, use a hoe to scrape the barnacles loose.

Stowage: When curtain is cleaned and dry, fold it up and place in covered storage if at all possible.

Repairs: Should repairs become necessary, Containment Systems, Corp. has repair kits. Clean the area to be repaired with acetone. Cut a patch larger than damaged area. Apply glue then put on the patch and roll vigorously with a bottle or can until dry. Takes approximately ten minutes to dry. Pop rivets and fender washers may also be used for repair jobs.

APPENDIX B
SUPPORTING INFORMATION FOR SEAGRASS CONTROL PROJECT

The following data are presented as Appendix B:

- Figure B-1: Seagrass Control Project Data Report
- Figure B-2: Incident Report: Pump Failure
- Table B-1: Summary report of PHM pump failures and their causes at NAVSTA Key West (January 82–July 83) (prepared by HYSAT, Inc.)

NOSC

SEAGRASS CONTROL PROJECT
DATA REPORT

Week of: ______________

Ship's Name: ______________

NOSC Contact: H Goforth
Autovon: 933-6542/6471
Commercial: (619) 225-6542/6471

	Mon	Tues	Wed	Thur	Fri	Sat	Sun
A. Berth Description							
1. Berth # (1-6)							
2. Moored (Port/Stbd) to Pier							
3. Boom In Place (Y or N)							
4. Grass/Debris Level — INSIDE BOOM							
N = None, L = Light, M = Mod, H = Heavy — OUTSIDE BOOM							
B. Pump Operation (Hr & Min = 00:00)							
1. In Port							
Pump #1							
Pump #2							
Pump #3							
Pump #4							
2. Underway							
Pump #1							
Pump #2							
Pump #3							
Pump #4							
C. Pump Failure (Requires Submission of Incident Report)							
1. Pump #							
2. Time							
3. Cause							

Comments: ______________________________

Petty Officer Of The Watch ______________

Div/Dept Head ______________

Figure B-1. Seagrass Control Daily Data Report.

INSTRUCTION SHEET FOR COMPLETING PUMP FAILURE INCIDENT REPORT

BACKGROUND INFORMATION

CLOGGING/FOULING OF PHM COOLING PUMPS HAS BEEN SUGGESTED TO BE ASSOCIATED WITH THE PRESENCE OF FLOATING GRASS AND DEBRIS IN THE MOORING OR OPERATING AREA. THE ENCLOSED INCIDENT REPORT HAS BEEN DESIGNED TO DOCUMENT THE FREQUENCY AND POSSIBLE CAUSE OF COOLING PUMP FAILURE.

EXPERIMENTAL FLOATING CURTAINS, OR BOOMS, ARE CURRENTLY BEING USED AROUND SHIPS AT THEIR MOORING BERTHS TO ESTABLISH THEIR EFFICACY AS DEVICES FOR SCREENING FLOATING GRASS AND DEBRIS FROM THE PUMP INTAKE PORT. THIS INCIDENT REPORT WILL PROVIDE A RECORD OF BOOM USE AND PUMP FAILURE. THESE DATA WILL BE USED TO EVALUATE BOOM EFFECTIVENESS.

THE REPORT

THIS INCIDENT REPORT IS DESIGNED FOR SIMPLICITY OF COMPLETION. THE MAJORITY OF QUESTIONS REQUIRE ONLY CIRCLING WORDS OR NUMBERS, OR PROVIDING ONE WORD OR A CHARACTER FOR SENTENCE COMPLETION. THE RESPONSES WHICH MAY BE CHOSEN TO ANSWER THE QUESTIONS ARE UNDERLINED FOR QUICK RECOGNITION.

THANK YOU FOR YOUR ASSISTANCE !

INCIDENT REPORT: PUMP FAILURE

SHIP NAME: ______________________________
DATE OF REPORT: __________________________

(NOTE: CIRCLE THE APPROPRIATE UNDERLINED WORD OR FILL IN THE BLANKS).

1. DURING LAST 24 HOURS, SHIP WAS: MOORED CONTINUOUSLY OR UNDERWAY AND MOORED.

2. PUMP USE: (GIVE TIMES OF USE).

	MOORED FROM	MOORED TO	UNDERWAY FROM	UNDERWAY TO
PUMP#1				
PUMP#2				
PUMP#3				
PUMP#4				

3. PUMP # ______ FAILED AT ______(HOURS) ___________ (DATE) WHILE SHIP WAS MOORED/UNDERWAY.

4. CAUSE OF PUMP FAILURE: GRASS/DEBRIS/OTHER. IF OTHER, SPECIFY:
____
____.

5. DOES FAILED PUMP HAVE A HISTORY OF MECHANICAL PROBLEMS? Y or N.

6. IF PUMP FAILURE OCCURRED WHILE SHIP MOORED:

a) SHIP WAS MOORED TO PORT OR STBD.

b) WAS GRASS IN BERTHING AREA? Y OR N.

c) IF YES, GRASS DENSITY WAS: LIGHT, MODERATE OR HEAVY.

d) WAS BOOM IN PLACE? Y OR N.

e) WAS GRASS INSIDE BOOMED BERTH? Y OR N.

f) IF YES, GRASS DENSITY WAS: LIGHT, MODERATE OR HEAVY.

g) BOOM WAS IN PLACE ______% OF THE TIME. (CONTINUOUSLY = 100% OF TIME).

7. IF PUMP FAILURE OCCURRED WHILE SHIP UNDERWAY:

a) SHIP WAS: ON/OFF HYDROFOILS.

b) IF OFF, HOW LONG OFF HYDROFOILS? _______ HOURS.

c) BRIEFLY DESCRIBE OPERATING AREAS WHERE SHIP HAD BEEN AND WHERE SHIP WAS AT TIME OF PUMP FAILURE INDICATING THE PRESENCE OR ABSENCE OF FLOATING GRASS OR DEBRIS. ______________________________

Figure B-2. Incident Report Form for pump failures.

Table B-1. Summary report of PHM pump failures and causes at NAVSTA Key West (Jan 82-July 83) (prepared by HYSAT, Inc.).

14 July 1983

SEA WATER PUMP AND RELATED SYSTEMS
MATERIAL HISTORY

SHIP	JSN	DESCRIPTION	DISC DATE
PHM 1	2133	NR 2 SW PUMP MOTOR OPEN	15 JAN 82
1/1/82	2381	NR 4 SW PUMP PIN HOLE LEAD	01 JUN 82
	2986-2989	ALL SW PUMPS CHANGED TO PRODUCTION NR 5 COMPLETELY REMOVED	17 JAN 83
	2913*	NR 3 SW PUMP SHORTED	12 FEB 83
	2942*	NR 4 SW PUMP DRAWS EXCESSIVE CURRENT	26 FEB 83
	2973	NR 3 SW PUMP INOP	08 MAR 83
	3021*	NR 1 SW PUMP PRESSURE SWITCH FAILED	29 MAR 83
	3040	NR 2 SW PUMP DISCHARGE VLV INOP	12 APR 83
	3046	NR 4 SW PUMP TRIPS PERIODICALLY	12 APR 83
	3083	NR 1 SW PUMP FAILED	05 MAY 83
	3146	NR 3 SW PUMP CHECK VLV FAILED	16 JUN 83
PHM 2	0392	NR 2 SW PUMP LOW PRESSURE SWITCH INOP	01 MAR 83
2/18/83	0452	ALL SW PUMPS HAVE INACCESSIBLE ZINCS	27 MAR 83
	0462	NR 2 SW PUMP LOW PRESSURE SWITCH INOP	29 MAR 83
	0512	NR 3 SW PUMP CHECK VLV FAILED	28 APR 83
	0666	NR 2 SW PUMP SEAL FAILED	30 JUN 83
PHM 3	0675*	NR 1 SW PUMP DRAWS EXCESSIVE CURRENT	02 SEP 82
8/11/82	0724	NR 2 SW PUMP CHECK VALVE FAILED	14 OCT 82
	0758	NR 2 SW PUMP CANNIBALIZED TO PHM 4	10 DEC 82
	0761	REPLACED ALL SW CHECK VLVS	15 DEC 82
	0772	NR 1 SW PUMP TRIPPED ON LOW OIL PRESSURE AFTER ONLY 21 HOURS OF OPERATION	10 JAN 83
	0852	NR 1 SW PUMP REGULATING SWITCH FAILED	01 FEB 83
	0865	NR 3 SW PRESSURE TRANSDUCER FAILED	25 MAY 83
	0866	NR 4 SW PRESSURE TRANSDUCER FAILED	25 MAY 83
PHM 4	0658*	NR 2 SW PUMP DRAWS EXCESSIVE CURRENT	06 SEP 82
8/11/82	0779	NR 4 SW PUMP GROUNDED	30 OCT 82

Table B-1. Summary report of PHM pump failures and causes at NAVSTA Key West (Jan 82-July 83) (prepared by HYSAT, Inc.). (Continued)

SEA WATER PUMP AND RELATED SYSTEMS (CONTINUED)

SHIP	JSN	DESCRIPTION	DISC DATE
PHM 4 (CONT)	0787*	SW CHECK VLVS HAVE DEMONSTRATED SHORT LIFE	30 OCT 82
	0855*	NR 3 SW PUMP DRAWS EXCESSIVE CURRENT	06 DEC 82
	1170	NR 1 & 3 SW PUMPS WIRED INCORRECTLY	10 FEB 83
	1101	NR 2 SW PUMP LEAKING SEA WATER	19 MAR 83
	1128*	NR 2 SW PUMP GRINDING	07 APR 83
	1130	NR 2 SW PUMP CHECK VLV FAILED	08 APR 93
	1134	NR 1 SW PUMP CHECK VLV FAILED	11 APR 83
	1131	NR 2 SW PUMP DRAWS EXCESSIVE CURRENT	08 APR 83
	1152	NR 2 SW PUMP PLASTIC TUBING LEAKS	19 APR 83
	1169	NR 2 SW PUMP DISCHARGE PIPING LEAKS	05 MAY 83
	1173	NR 1 SW PUMP CHECK VLV FAILED	05 MAY 83
PHM 5	0518	NR 3 SW PUMP CHECK VLV FAILED	16 DEC 82
12/15/82	0584	NR 1 SW PUMP FAILED	31 JAN 83
	0594	NR 1 & 3 SW PUMPS LEAKING AND HAVE GROUNDED LOW PSI SWITCH	04 FEB 83
	0616	NR 3 SW PUMP LOW PSI SWITCH FAILED	16 FEB 83
	0623	NR 2 SW PUMP LOW PSI SWITCH FAILED	22 FEB 83
	0679	FAILURE RATE OF SW SERVICE PUMPS HAS BEEN EXCESSIVE, SQUADRON FAILURE RATE HAS BEEN ON THE ORDER OF THREE PER MONTH, LONG RANGE REMEDIAL ACTION IS MORE RELIABLE PUMPS. SITUATION WOULD BE PARTIALLY EASED BY FIRE MAIN SERVICES ON PIER TO ENABLE COMPLETE SHUTDOWN OF SHIPBOARD SALT WATER PUMPS AND AVAILABLE COOLING FLOW FOR AIR CONDITIONING PLANT. SHORT TERM ASSIST WOULD BE PORTABLE SW PUMP ON PIER TO COOL AC PLANT AND ONLY USE THE SHIP'S SW PUMPS TO PRESSURIZE FIRE MAIN IN THE EVENT OF A FIRE.	31 JAN 83
	0745	NR 3 SW PUMP DRAWS EXCESSIVE CURRENT	29 APR 83
	0773	NR 4 SW PUMP DRAWS EXCESSIVE CURRENT	18 JUN 83

Table B-1. Summary report of PHM pump failures and causes at NAVSTA Key West (Jan 82-July 83) (prepared by HYSAT, Inc.). (Continued)

SEA WATER PUMP AND RELATED SYSTEMS (CONTINUED)

SHIP	JSN	DESCRIPTION	DISC DATE
PHM 6	0388	NR 3 SW PUMP CHECK VLV FAILED	27 FEB 83
2/18/83	0392	NR 4 SW PUMP LOW PSI SWITCH FAILED	04 MAR 83
	0407	NR 2 SW PUMP CHECK VLV FAILED	14 MAR 83
	0416	SW STRAINERS HAVE BROKEN HANDLES	27 MAR 83
	0444	NR 3 SW PUMP CHECK VLV FAILED	06 APR 83
	0445	NR 3 SW PUMP OPEN 'C' PHASE	07 APR 83
	0457	NR 3 SW PUMP LOW PSI SWITCH FAILED	14 APR 83
	0541	SW PUMPS EXCESSIVE FAILURES CITED	21 MAR 83
	0568	NR 1 SW PUMP LEAKS WATER	10 JUNE 83
	0569	NR 2 SW PUMP LEAKS SW AND LUBE OIL	10 JUNE 83

NOTES:

1. * INDICATES CASREP
2. DATES UNDER PHM'S INDICATE DATE SHIP ARRIVED AT KEY WEST

PREPARED BY
HYSAT INC.
83194/24

APPENDIX C
A REVIEW OF SEAGRASS BIOLOGY

INTRODUCTION

There are between 35 and 50 species of seagrasses in the world (number varies depending upon taxonomic classification), the majority of which are strictly tropical in their distribution (Humm 1973 and den Hartog 1970). Because of their important ecological role and ability to entrap and stabilize sediments, seagrasses have been the subject of much research (reviews: Thayer et al. 1975, Zieman et al. 1978, and Phillips and McRoy 1980).

Six species of seagrass occur in Florida waters, three (*Ruppia* and two species of *Halophila*) are only minor components of the seagrass communities. The remaining three species (*Thalassia, Halodule*, and *Syringodium*) are all found in the Florida Keys. Turtle grass (*Thalassia testudinum*) is the dominant species comprising 60–75% of all the seagrass bottom coverage and biomass (Humm 1973). The distribution of turtle grass is essentially continuous along both Florida coasts from Pensacola to Sebastian Inlet.

ENVIRONMENTAL LIMITING FACTORS

Several environmental factors determine the limits of growth and survival of turtle grass. The primary factors are air and water temperature; salinity; substrate (composition and depth); tidal exposure; and irradiance (i.e., quality and quantity of light) which is determined by the season, water depth, and turbidity. The terms used in this review to describe the size and growth of seagrass beds are: density (number of leaves/m^2), leaf standing crop (g dry weight/m^2), leaf production (g dry weight/m^2/day), leaf growth rate (mm/day), and turnover rate (% change/day).

Temperature

Turtle grass lives in a temperature range of 20–30°C, yet it can survive for short periods at 10°C (Phillips 1960). Maximum productivity was found at 30°C with rates declining to zero at temperatures below 19 and above 36° (Zieman 1975a). Warm summer temperatures (e.g., 30–37°C) increase metabolism, but at the same time reduce water solubility of carbon dioxide (a metabolic requirement for photosynthesis). This causes plants in warm shallow water (e.g., tidal flats in the Florida Keys) to become flaccid, deteriorate, and break loose to form the rafts of drifting seagrass observed in the summer (Phillips 1960).

Salinity

The range of salinities for turtle grass growth appears to be 24–35 ppt. The optimum salinity is reported to be 30 ppt (Zieman 1975a). Productivity decreases on both sides of the optimum, however turtle grass is known to survive short periods at salinities as high as 48 ppt and as low as 10 ppt (Phillips 1960). Gessner (1971) reported turtle grass surviving in hypersaline bays of Venezuela at prolonged salinities of 45–50 ppt.

Substrate

One consistent substrate requirement for good growth is reported to be the presence of calcium carbonate. Turtle grass sediments contain at least 50% shell and less sand and clay than that of other seagrasses (Pulich et al. 1976). Additionally, an anaerobic substrate condition is necessary to support nitrogen fixation by bacteria which is the only source of nitrogen for the plant (Patriquin 1972 and van Bredveld 1975). Sediment depth is also important and has been found to correlate positively with turtle grass leaf density. Zieman (1972) reported that a minimum sediment depth of 20–25 cm was necessary for the establishment of a "healthy" (greater than 1000 leaves/m^2) turtle grass bed. The maximum density of 10,000 leaves/m^2 was found only in beds where the sediment depth exceeded 50 cm. Wanless (1976) found that in South Florida, seagrass beds were absent where the bay bottom had less than 15 cm of sediment over the bedrock.

Tidal Exposure and Zonation

The upper tidal limit of turtle grass is determined by its susceptibility to desiccation when exposed to air during low tides (Strawn 1961 and Phillips 1960). Turtle grass has relatively stiff leaves which do not bend sufficiently to remain in contact with the film of water or damp bottom during low tides. The upper tidal limits are therefore determined by the leaf characteristics and the degree of protection against dehydration afforded by residual water during low tides (Strawn 1961). The lower tidal limit for turtle grass is determined by water clarity which affects the quality and quantity of light reaching the leaves. Red light (620 nm) is the most useful for turtle grass growth, however, this is also the wavelength most quickly absorbed by seawater (Buesa 1974). Experiments in Cuba and Venezuela have found that turtle grass can photosynthesize down to depths of 20–30 m (Gessner and Hammer 1961). Along the Gulf Coast of Florida the maximum depth of turtle grass is between 6 and 9 m but in the Keys the maximum depth may be 20–23 m. Typically, turtle grass beds occur from the mean low (M.L.) tidal level out to a depth of 6 m.

STANDING CROP AND PRODUCTION

Turtle grass leaf production averages approximately 1.5 kg of organic matter/m^2/yr. Leaf growth rates in the Keys average 2–4 mm/leaf per day with a biomass production of 4–7 g dry weight/m^2 per day (Buesa 1974, Zieman 1975, and Thorhaug and Roessler 1977). In South Florida, turtle grass produces 6–7 crops/yr with leaf replacement rates averaging 2% of the leaves per day (Zieman 1975a). This means that the standing crop of turtle grass leaves is replaced approximately every 50 days. The density of turtle grass beds varies from 250–6,000 blades/m^2 and averages 3,500–4,300 blades/m^2. Leaves constitute 15–22% of the total plant biomass with leaf standing crops averaging approximately 250 g dry weight/m^2. Turtle grass beds exhibit seasonal fluctuations that result in a minimum winter biomass that is 50% of the maximum observed in the summer. When not affected by other environmental factors, turtle growth is continuous but fluctuates with temperature. Growth reaches a maximum between late spring and early fall (May–Sept) with a minimum of almost zero production from November to January.

TURTLE GRASS LONGEVITY AND DECAY

Turtle grass leaves cease growing after 25–35 days but remain attached to the shoot for 21–28 days more until they break off at their base. A number of environmental conditions may interfere in the "normal" 43- to 63-day life span of a leaf. Under normal conditions a shoot produces a new leaf every 14–16 days (with 4–5 leaves/shoot). Extra large amounts of drifting turtle grass are frequently observed following periods of strong winds and minus tides between 1200–1700 hours. Humm (1983) reports that turtle grass can lose up to 65% of its water content before damage occurs. A loss of 72% is lethal. This loss frequently occurs in beds on tidal flats of the Keys on sunny days during minus low tides, thus producing extensive leaf kills. The subsurface portions of the turtle grass plant survive however, and a new crop of leaves is produced in 2–3 weeks. Phillips (1960) presents a good review of the factors associated with the natural phenomenon of turtle grass kills. Environmental extremes appear to be responsible for the mass loss of leaves as observed in both summer and winter. Exceptional conditions such as hurricanes ("Donna" 1960) have been reported to deposit an average of 17 kg of dried seagrass per meter of shore line (Thomas et al. 1961). Degradation of dead turtle grass leaves occurs at a rate of 10% per week during the first 7 weeks, but complete degradation may take a year (Zieman 1975a and Odum et al. 1972). It appears quite clear that accumulations of drifting seagrass are a natural phenomenon which man must either tolerate or learn to control.

APPENDIX D
COMPHMRON-2 LETTER REQUESTING
AN EXPANDED CONTAINMENT BOOM STUDY

DEPARTMENT OF THE NAVY

COMMANDER
PATROL COMBATANT MISSILE
HYDROFOIL SQUADRON TWO
FPO NEW YORK, NY 09501

COMPHMRON2:CHR:pe
3100
Ser 284
8 November 1983

From: Commander, Patrol Combatant Missile Hydrofoil Squadron TWO
To: Commander, Naval Surface Force, U. S. Atlantic Fleet
Via: Commander, Cruiser Destroyer Group TWELVE

Ref: (a) COMNAVSURFLANT Norfolk, VA 252311Z JAN 83
(b) NAVSWC Silver Spring, MD 111351Z MAR 83

Subj: Seagrass Blockage of Seawater Intakes at NAS Key West

1. During the recent Key West port visit by the USS DALE (CG 19) significant engineering difficulties were encountered due to the injestion of Turtle Grass (sea grass) into all seawater intakes, main and auxillary condensors and fire pumps. The problem became so acute during the ebb tides that the USS DALE was forced to depart Key West one day earlier than scheduled.

2. In an effort to assist the ship and prevent the injestion of the turtle grass, the boom system discussed in reference (a) and currently in use by the PHM squadron was diwereted for use by USS DALE. Due to its length it was only capable of providing partial blockage of the turtle grass around the stern to about midships on USS DALE. While it made a noticable difference for several ebb tides for the after plant, continued injestion of turtle grass was experienced. It is conjectured that if the boom system with its sheet had been long enough to completly encircle the ship enough protection would have been provided to enable the USS DALE to remain inport for her entire visit. However, the boom system cannot be proven to provide adequate protection without actually testing one of commensurate size. The current boom system test for the PHM squadron is nearing completion and has proven successful. Accordingly it is requested that COMNAVSURF-LANT expand the NSAP TASK SURPL-1-83 be expanded to include a test boom for ships up to 550-600 FT in length.

3. Previous experiences with turtle grass injestion have occurred at Truman Annex after mole during periods of time when the wind is primarily from the North to Northeast during ebb tide. These winds are prevelant from October until Spring. Beginning 1 November 1983 the outer mole will no longer be available for use due to refacing of this pier. It is therefore further requested that if the NSAP TASK is expanded as requested that the larger boom system be made available in the April/May time frame.

F. G. HORN

Copy to:
USS DALE (CG 19)
CO, NAS Key West
NOSC San Diego, CA (Code 5143)

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